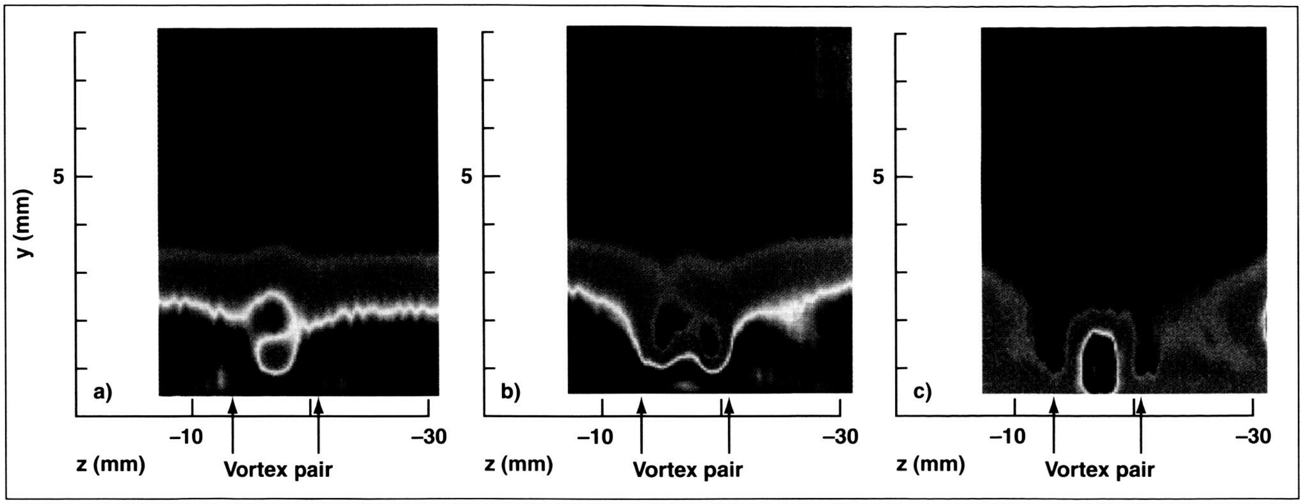

Fig. 2. Distortion of Tollmien–Schlichting wave amplitude in three spanwise planes downstream of the vibrating ribbon for the case with the FSN induced streamwise vortices embedded in the layer. (a) x = 1.15 m, R = 876 (= $R_x^{1/2}$); (b) x = 1.25 m, R = 914; (c) x = 1.35 m, R = 950.

results in rapid growth in amplitude (e.g., $u/U_1 \approx$ 10% for R = 984) and in the onset of random behavior, which is a characteristic of the final approach to breakdown to turbulence.

A different type of secondary instability mechanism appears to be associated with the vortices, which leads to transition at a lower Reynolds number. The results help explain the adverse effects of wind tunnel flow quality on tests concerning bodies with substantial regions of laminar flow.

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The Effects of Thin Paint Coatings on the Aerodynamics of Semi-Span Wings

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The objective of this research was to measure the effect of pressure-sensitive paint (PSP) on the aerodynamic performance of high-aspect-ratio, semi-span wings at transonic cruise and landing conditions. The PSP technique for measuring pressure distributions on wind-tunnel models requires coating the surface of the model with special paint that luminesces when illuminated by light of appropriate frequency. The technique has the potential to eliminate the need for pressure taps in wind tunnel models while yielding pressure information over entire surfaces rather than just at discrete points. The presence of paint on a model, however, can alter the flow (that is, it can become "intrusive") by adding thickness to the model or by changing the roughness of the model and thus altering the development of the boundary layer. Changes in surface roughness are likely to be most critical at high Reynolds numbers where boundary layers are thinner.

Two models were tested: (1) a single-element, supercritical wing at transonic cruise conditions in High Reynolds Number Channel 2 (HRC-2); and (2) a multi-element wing-body model complete with slats, flaps, and engine pylon and nacelle at landing conditions in the Ames 12-Foot Pressure Wind Tunnel. The effect of the paint was determined by comparing pressure-tap data (both models) and balance data (high-lift model only) from runs with and without paint on the models.

Paint intrusiveness was measured on both models. The shock wave on the cruise model was displaced slightly upstream when the model was painted relative to when it was not painted. This occurred at all Reynolds numbers (7.3 million to 13.6 million) even after the paint had been polished to a "hydraulically smooth" finish. The stall angle of the high-lift model at the highest Reynolds number (6.7 million) was nearly 4 lower when there was unpolished paint on the leading-edge slats compared to when the model was unpainted (figure 1). Polishing the paint on the slats restored the stall to its paint-off behavior. Applying paint to other parts of the wing had very little effect. Even before being polished, the paint was hydraulically smooth at all Reynolds numbers (3.4 to 6.7 million).

These experiments demonstrated that pressure paints applied to wind tunnel models must be very smooth. The roughness of paint along the leading edges of high-lift models is especially important. Accepted roughness criteria developed for simplified geometries may not apply to complex, three-dimensional configurations. This research shows the importance of assessing the intrusiveness of pressure paint whenever it is used.

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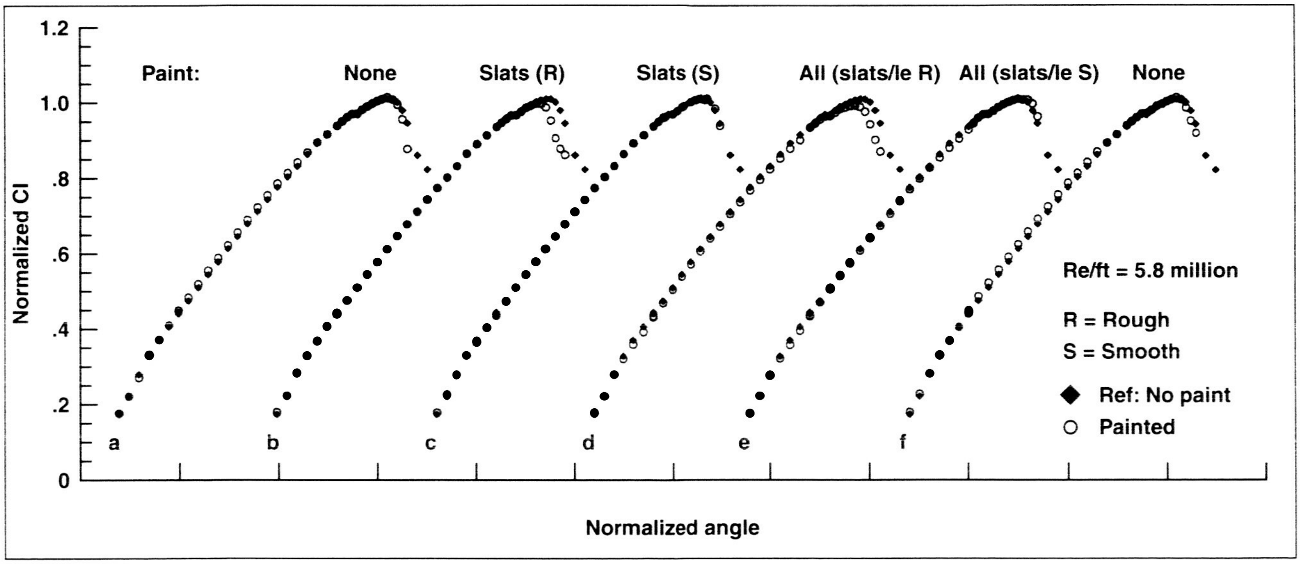

Fig. 1. Comparison of paint-off and paint-on lift curves of high-lift wing at maximum Reynolds number (6.7 million).